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AUXILIARY DUCT AIRFLOW DETERMINATION IN LINGAN PHALEN USING SF_6

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by

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ABSTRACT

An experiment was conducted to compare the measurements of airflow in an auxiliary duct using a pitot tube and tracer gas. This report briefly describes the methodology and results of the test.

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DÉTERMINATION DU DÉBIT DE L'AIR DANS UNE GAINE DE VENTILATION AUXILIAIRE DE LA MINE LINGAN PHALEN À L'AIDE DE SF_6

par

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RÉSUMÉ

On a fait une expérience dans le but de comparer les mesures du débit de l'air dans une gaine de ventilation auxiliaire à l'aide d'un tube pilote et d'un gaz traceur. Ce rapport présente une courte description de la méthodologie et des résultats de l'essai.

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CONTENTS

	Page
ABSTRACT	i
RESUME	ii
INTRODUCTION	1
Pitot Tube Determination	1
Tracer Gas Determination	2
CONCLUSIONS	5
REFERENCES	5

TABLES

No.		Page
1.	Results of the pitot tube traverse	1

FIGURES

No.		Page
1.	Velocity profile in the duct	3
2.	SF_6 concentrations measured across the roadway	4

INTRODUCTION

The Cape Breton Coal Research Laboratory (CBCRL) is committed to an infield evaluation of the use of water jet assisted roadheaders in the Sydney Coalfield. Part of this evaluation is a comparison of the dust production of water jet assisted cutting versus conventional roadheader cutting. To allow an accurate measurement of this, a precise value of the airflow in the tunnel is required. Dust concentrations are measured at a station located 70 m back from the heading face. Air is delivered to the roadheader through a 0.76 m (30") diameter forced air duct located in the roadway. Some doubt was expressed over the accuracy with which the flow in the duct could be measured using a pitot tube, due to the irregular duct shape. An experiment was conducted where a pitot tube measurement of the flow in the duct was compared to the same flow measured by a release of tracer gas. This report describes the results of this experiment.

PITOT TUBE DETERMINATION

The pitot tube traverse was done in accordance with the procedure described by Hartman (1). Nine measurements were made in a single traverse across the duct. The results of this traverse are listed in Table 1.

Table 1 - Results of the pitot tube traverse

Distance into Duct (mm)	Velocity Pressure (Pa)	Airspeed (m/s)
4	49	9.9
11	52	10.2
15	57	10.7
26	31	7.9
48	19	6.2
58	15	5.5
63	12	4.9
68	10	4.5
72	9	4.2
TOTAL		64
AVERAGE		8

The results show that the flow across the duct was not symetrical. The flow in the lower half was higher than in the upper half. Figure 1 is a schematic representation of the velocity profile in the duct.

The average velocity measured in the duct was 8 $m.s^{-1}$. When multiplied by the internal cross-sectional area of the duct (0.456 m^2) this gave an airflow of 3.65 $m^3.s^{-1}$ (7730 cfm).

TRACER GAS DETERMINATION

The tracer gas used in this experiment was sulphur hexafluoride (SF_6) which was released into the duct 70 m back from the face at the dust measuring station. It was released from a lecture bottle containing pure SF_6 through a limiting critical orifice at a steady flow rate of 44.8 ml/min.

The tracer gas was given sufficient time to achieve steady state concentrations in the duct and tunnel. Samples of air were then collected from eleven locations across the tunnel cross-section (Figure 2) at the dust measuring station. The SF_6 concentrations measured in these air samples are marked next to the appropriate spatial coordinates in Figure 2. It can be seen that all the concentrations were between 32.9 and 30.1 ppb, less than a 3.0 ppb variation. The concentrations are higher towards the top of the tunnel and lower near the floor. This variation may have been due to a fluctuation in the air delivered quantity during the time it took to collect the eleven samples.

Two sweep samples were collected before and after the spot samples. These contained 32.2 and 32.0 ppb respectively. This agrees closely with the average of the eleven spot samples of 32.05 ppb.

Substituting this concentration into the equation,

$$Q = \frac{\dot{m}}{c} \qquad \text{Eq 1}$$

where, Q is the airflow (m^3/s)

$\dot{m}$ is the release rate of SF_6 (m^3/s)

and c is the measured SF_6 concentration

the SF_6 determination of the airflow in the tunnel at the measuring station was 3.5 m^3/s (7400 cfm).

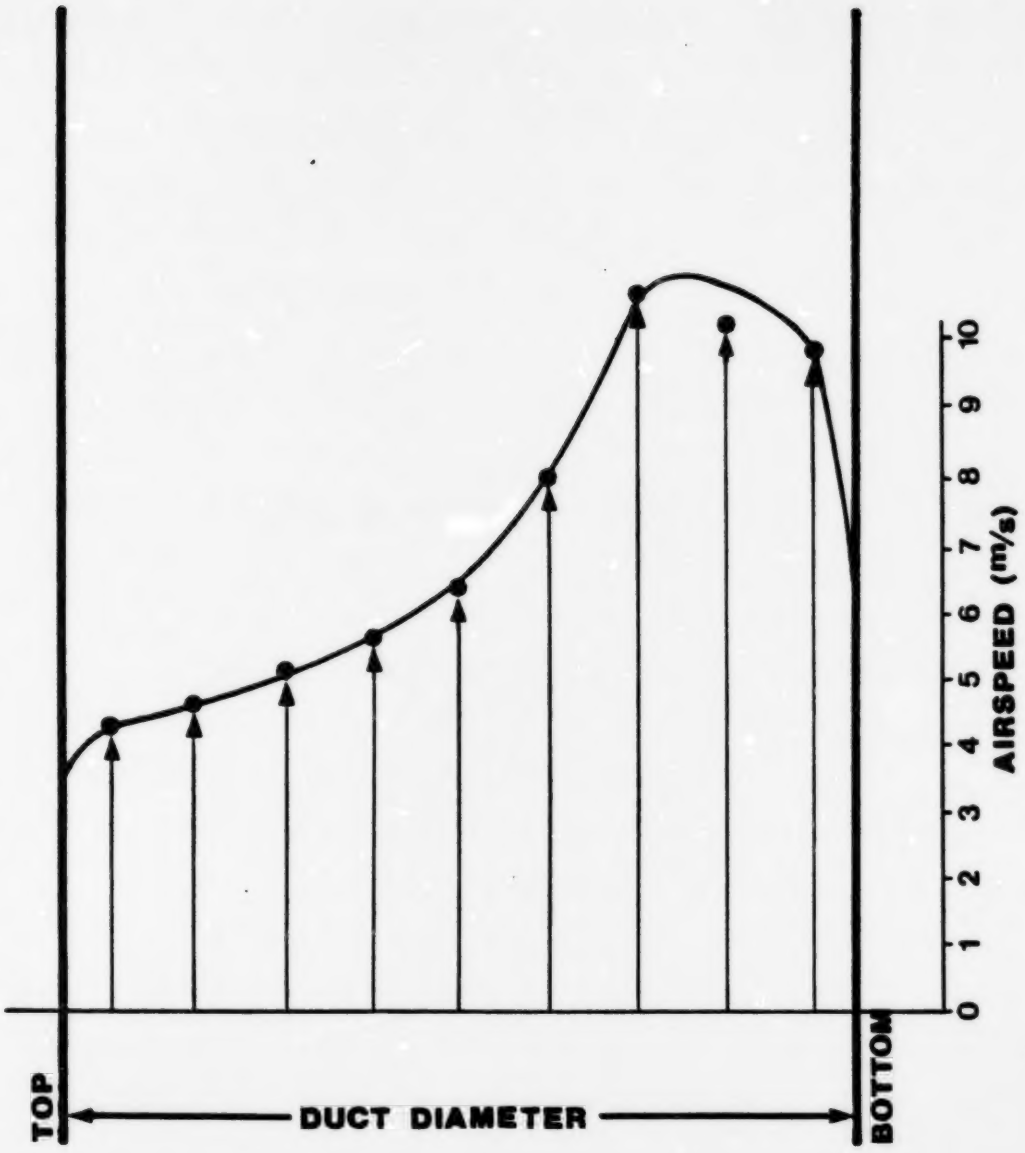

Figure 1 - Velocity profile in the duct

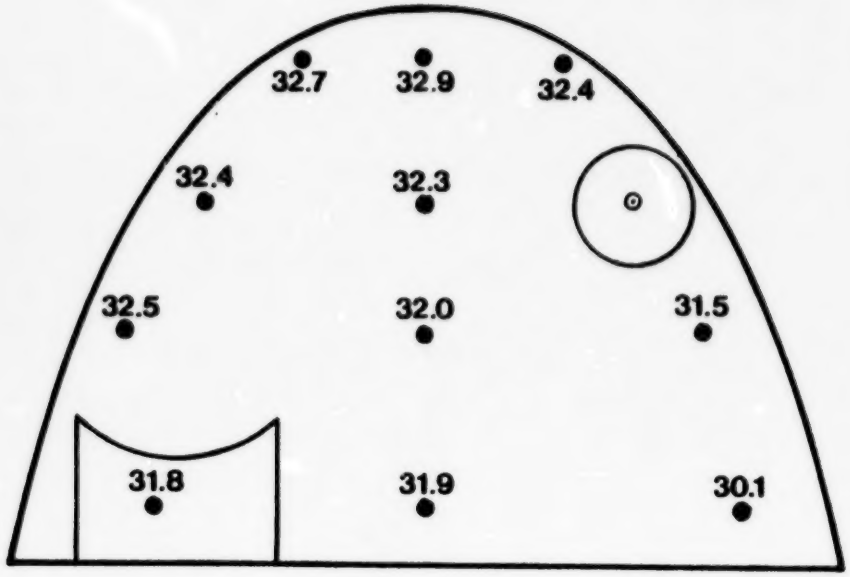

Figure 2 - SF_6 concentrations measured across the roadway

CONCLUSIONS

The difference in the airflow measurements made in the duct using the pitot tube and in the roadway using SF_6 was 4.2%. Given the rough field conditions in tunnel No. 4 this agreement was excellent. It has been shown that the pitot tube can measure the duct airflow to better than ±5% even when the velocity profile in the duct is irregular.

It was also shown that releasing SF_6 into a high velocity airstream in a duct produced good mixing in the 70 m length before it was discharged. This may be useful in future surveys when good mixing is required. Previous surveys have shown that SF_6 released directly into a roadway airstream can produce a noticeable concentration profile across the roadway cross-section several hundred metres downwind of the release point.

REFERENCES

1. Hartman, H.L. "Mine ventilation and air conditioning"; 2nd Edition; 1982.